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Calibration of the Talbot - Jones Brick - Testing Machine

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CALIBRATION

OF THE

TALBOT-JONES BRICK-TESTING MACHINE

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This is to certify that the thesis prepared under the supervision of Professor Talbot by FRED ELMER RIGHTOR and GEORGE CONRAD HABERMEYER, entitled CALIBRATION OF THE TALBOT-JONES BRICK-TESTING MACHINE, is approved by me as fulfilling this part of the requirements for the Degree of Bachelor of Science in Civil Engineering.

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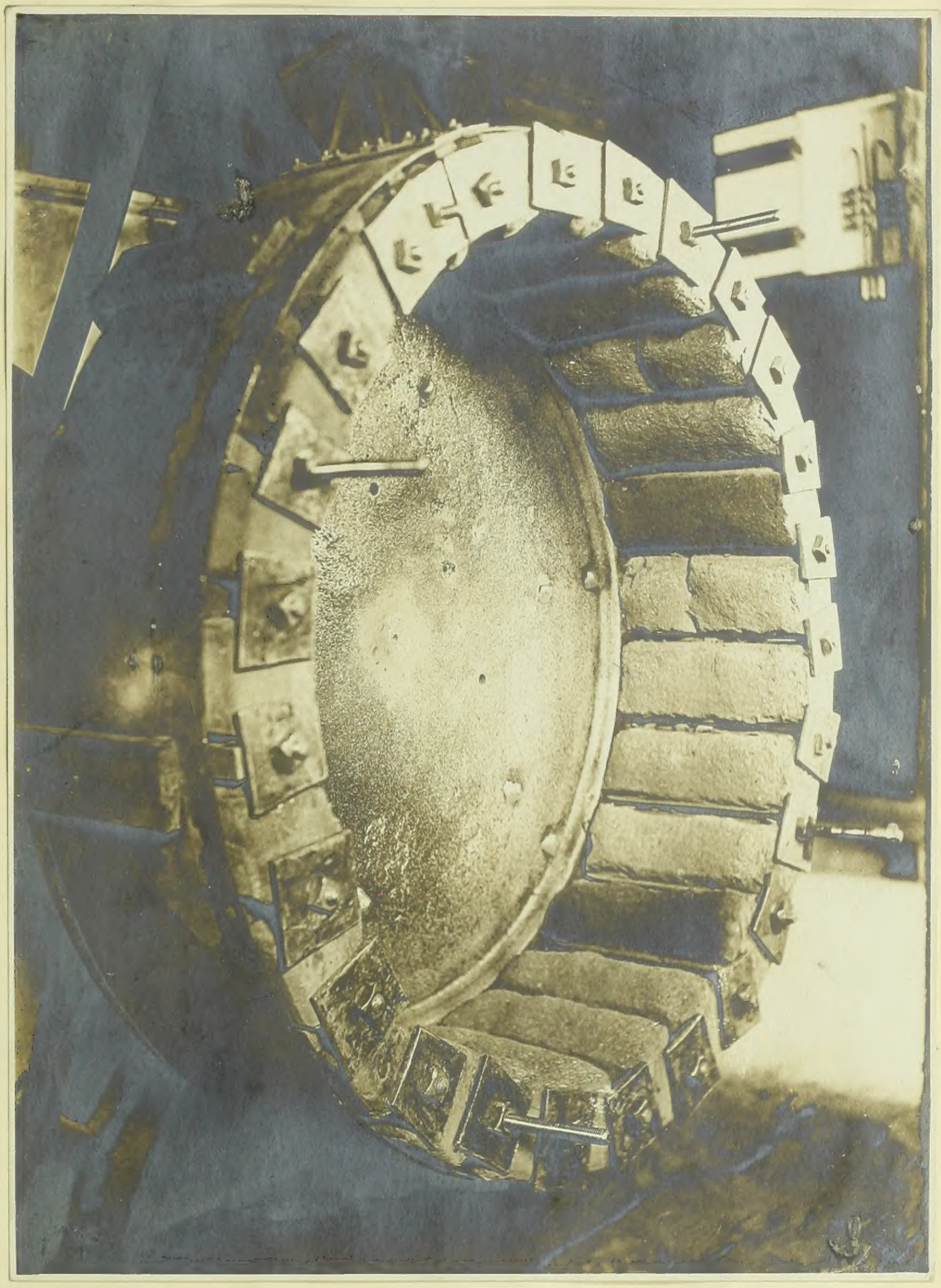
TALBOT - JONES BRICK - TESTING MACHINE ·



· VIEW AFTER RATTLING ·

Calibration of the Talbot-Jones Brick Testing Machine.

Introduction.

The object of this work is the calibration of the Talbot-Jones Brick Testing Machine, or as it is more commonly called the Talbot-Jones rattler. The calibration of this machine will be the determination of four constants, viz;
(1) the proper spacing of bricks in the rattler,
(2) the proper speed at which to run the machine,
(3) the weight of shot, and proportions of large and small shot to be used in the charge, and
(4) the number of revolutions, or time necessary for a complete test.

Before describing the experimental work, an outline of the methods of testing paving brick, and also a brief history of the rattler process will be given.

Following are the important points which should be observed in a test of paving brick;
(1) The test should give the proper amount

of impact and abrasive effects, and the proper relation between the action of each.
(2) It should give a clear and certain distinction between different grades of brick.
(3) A good opportunity should be given for testing individual brick.
(4) The test should require an economical a time as possible, the mechanism should be simple so that a skilled workman would not be needed to conduct the test.
(5) The effect of slight variations from standard conditions should be small.

All paving brick tests have attempted to fulfill the above conditions, but it is only in recent years that definite methods for testing brick have been used. Even now an ideal test is not known, although very satisfactory results are obtained by the present rattler process. Of the four principal tests which may be applied to paving brick, viz; crushing strength, transverse strength, absorption test, and impact and abrasion test, the last gives by far the most satisfactory results, and as a

method of comparing different makes of brick is of more importance than all of the other methods combined.

It is not necessary to go into a discussion of the first three tests named above, as they do not enter into this work, and moreover are not as commonly used for the purpose of brick testing as the impact and abrasion test. Valuable data on the "Comparison of Paving Brick Tests" is found in the thesis for bachelor's degree, by Mr. John Barr, University of Illinois, 1902.

The impact and abrasion test is made by rolling the brick to be tested, with or without pieces of iron, or as is done in the Talbot-Jones machine, rolling pieces of iron on the brick in a revolving cast iron barrel. This test most really imitates the impact due to pounding of horses' hoofs and shoes, and bumping of wheels, and also the abrasion due to sliding of the wheels and slipping of the horses' feet; and this slipping of the iron over the brick is very similar to the treatment which

a brick will receive in the pavement. Many experiments were made by Professor Edward Orton, Jr., of Ohio State University, under the auspices of the National Brick Manufactures' Association, to determine the size and form of rattler, and the kind of charge to be used. At the same time Professor A. N. Talbot, of the University of Illinois, was conducting a series of experiments to determine the composition and size of the abrasive material. In 1900 the National Brick Manufactures's Association adopted a standard using Professor Talbot's abrasive material, and published a set of specifications for the rattler test of paving brick, and these specifications are now widely used. Professor Talbot by his experiments determined that the abrasive material used should be of iron, and this iron was to be used as a mixed charge of two sizes of cast iron blocks. For dimensions of two sizes of blocks refer to paragraphs 3 and 4 of N.B.M.A. specifications. This also gives proportions used.

The N.B.M.A. standard test, in which the charge of shot is rolled with the brick in the rattler, as castings are rolled in a foundry rattler is not entirely satisfactory, as it gives no idea as to the uniformity of the individual bricks, merely determining the average loss of two charges of brick. With the purpose of improving on this method, Mr. Gromer Jones, city engineer of Geneva, N.Y., devised a rattler in which the bricks were placed in pockets on the inside of the staves of the rattler, a charge of cast iron cubes then being put in. In 1900, Professor Talbot proposed a substitute for this rattler, in which the bricks are clamped against an iron cylinder by means of bolts between the bricks and bearing on their ends. In this way the brick form a lining which more nearly represents the brick as they appear in the pavement than would be possible by any other method.

Professor Orton made a very complete set of experiments with the Talbot-Jones rattler for the purpose of calibrating the machine, and gave out the following standard conditions :— A charge of 150 pounds of shot, 60 pounds of 2 3/8 inch cast iron cubes, and 90 pounds of 1 1/2 inch cubes, and a speed of 41 revolutions per minute for 3000 revolutions. He also recommended a spacing between bricks of one inch. Messrs Charles W. Malcolm and John Barr, in their investigations for theses in 1902, used a spacing of 1/4 inch, and this permitted a uniform spacing and more nearly represented the spacing in the pavement, but other than this change the rattler was run under the conditions determined by Professor Orton.

This change in spacing from one inch to 1/4 inch requires a new set of experiments to determine the constants to be used in running the brick testing machine, and it is the

intention of the writers to find the proper loading and proportions of abrasive material, the proper speed and length of test for the Talbot-Jones Brick Testing Machine using a spacing between bricks of 1/4 inch.

Description of Apparatus.

The Talbot-Jones rattler is made of a short cylinder of sheet steel, the bricks being clamped against this cylinder. This sheet steel cylinder is fastened to a cast iron face plate by bent steel bars. A space of 5/16 inch is left between the face plate and the cylinder to allow dust and chips to escape. A 'T' shaped groove is made around the face plate about 1½ inches from the circumference. This groove opens to the front and the heads of the bolts are placed in it. These bolts are pulled from the back into the groove through six 1½ inch holes in the back. About 3½ inches from the circumference the face plate is recessed 7/8 inch. This arrangement leaves the inner edge of the back end of the brick unsupported, allowing the cast iron cubes to have their full effect on the brick. Wooden shims or spacers are placed between

the bricks to keep them properly spaced during the test. A wooden cover, recessed like the face plate, is used to cover the open end of the rattler. To allow more careful observation of the action of the shot on the brick, the writers designed a wire screen cover. The first screen used was strengthened by two wooden cross-pieces. This screen, however, proved unsatisfactory, as it bent under the action of the shot and was soon badly worn. A heavy screen, one such as is used in a locomotive fire box was then obtained; this was used without cross bracing and proved very satisfactory. These screens were used in all of the preliminary tests.

In making these tests, two sizes of shot, 2 3/4 inch and 1 1/2 inch cast iron cubes were used. The spacing was kept the same throughout the tests, that is 1/4 inch between bricks, or a loading of twenty-six bricks.

Description of Tests.

In performing these experiments, the paving brick used are divided into three classes, namely under-burned, medium, and over-burned. The first and last mentioned classes are not suitable for paving purposes, while the medium brick are such as would be accepted by an inspector, and left in the pavement. This grading was done by eye, depending on the color and general appearance of the brick. The writers are indebted to Mr. Gearhart, pavement inspector of Champaign, Illinois, for valuable instruction in the proper classification of paving brick.

This method of selecting brick is, however, not entirely satisfactory, especially in the case of overburned brick. There may be fire flash on the surface which tends to give the brick the appearance of being over-

burned, while in fact, such brick may be the most durable in the pavement, a fact made evident by some of the tests with overburned brick. This, however, is the customary method of judging brick, and since it is sufficiently accurate for this work will be the method used.

All of the following tests were made with Clinton paving brick. For an accurate test, it is desirable that very dry brick should be used. The brick used in these experiments had for several months been kept in a room heated by steam, and were in the best of condition for making the tests.

For purposes of making obseration and getting a general idea of the action of different charges of shot at different speeds, about fifteen preliminary tests were made. After some idea as to the standard conditions of a test was gained from these experiments a series of careful tests were per-

formed for the purpose of getting final results.

(1) Preliminary Tests.

Of the preliminary tests, the first eight were made with good Clinton paving brick, two were made with overburned, or hard Clinton brick, and three with underburned, or soft Clinton brick.

(a) Tests with Medium Clinton paving brick.

The first test was made with a charge of 150 pounds of shot, 15 per cent being 2 3/8 inch cubes. The rattler was run at the three speeds of 30, 36, and 41 revolutions per minute, for 100 revolutions. The last speed 41 R.P.M. is the one recommended by Professor Orton in the results of his tests. The weights of abraded material were found, chips being weighed first, then total of material worn off. The action of shot was also carefully observed. This test was repeated to get average results.

The second test was made with 150 pounds of shot in proportions recommended by Professor Orton, that is 40 % large shot and 60 % small. This test was carried out exactly as first one. In this test, the action of shot was observed by several persons familiar with paving brick tests, and the unanimous conclusion was that the amount of shot used was too great. Other conclusions from this test will be discussed under the heading "Results of Tests."

Having decided that the charge of shot was too great, the machine was loaded with 100 pounds of shot in proportions of 40% large and 60% small cubes. The method used in the previous tests was followed in this case.

For the fourth test, the charge used was 75#, the proportions being as above 40% large, and 60% small. The method of the previous

tests was followed.

In the fifth test, a charge of 100#, all large shot was used, the testing being conducted as in former cases.

Next, the machine was run with a charge of 75#, all small shot, the test being run as before.

The seventh test was made with 65# of shot, 40% large. In this test the rattler was run as before, but it was run for 480 revolutions.

The last test with good Clinton brick was made with 75# shot, one third being large, running the rattler 500 revolutions.

The data found as result of these tests is shown in Table I.

(b) Tests with Overburned Clinton brick.

The first test with the overburned brick was made with 75# of shot 40% large. The plan used above was followed, the number of revolutions

used, however, being 500 instead of 100 as before

A charge of 100#, 40% large, was then run for 500 revolutions as in the other experiment, but the test was not repeated, as the brick were considerably worn.

The data for these two experiments will be found in Table III.

c) Tests with Under-burned brick.

First a charge of 75#, 40% large was run for 200 revolutions; then a charge of 100#, 40% large; and lastly a charge of 65#, 40% large. In all of these three tests, the rattler was run for 200 revolutions without repeating

The data collected in these three tests are found in Table IV.

(2) Description of Final Tests:

After completing the preliminary tests, it was decided that a speed of 36 R.P.M. was preferable, as will be shown, so all of the following tests were made with the rattler running 36 R.P.M.

(a) First a series of tests were made with good Clinton brick, the rattler running 200 revolutions for each test. The first tests were made in following order, (1) 75# shot 0% large, (2) 100# shot, 0% large, (3) 75#, 40% large, (4) 100# 40% large, (5) 75#, 60% large, (6) 100#, 60% large. These tests were then repeated in the reverse order, giving a good average for each test.

The data collected from these tests are tabulated in Table II.

(b) Next, a series of tests were carried out to get a comparison of the losses with charges of 75# and 150#. In these tests the rattler was loaded with soft Clinton brick, and run for 3000

revolutions with a charge of 75# of shot 40% large. The same experiment was performed with good brick, and also with overburned brick, the same charge and number of revolutions being used as for the underburned brick. These tests were repeated to obtain average results. A charge of 150#, 40% large was then run in the rattler with the three different grades of brick.

In these tests, the individual bricks were weighed before the test, numbered, and re-weighed after the test, thus giving the loss sustained by each brick. In addition to this, the abraded material was weighed to obtain the relation between loss by chipping and dust worn off.

The data from these tests are shown in Tables V, VI, and VII.

Results of Tests:

(1) Preliminary Tests.

For all data as to speed and amount of abraded material see Tables I, III, and IV for medium, overburned and underburned Clinton brick respectively.

(a) Tests with Medium Clinton brick.

In the first test, load being 150#, 15% large shot, it was found that the shot, at the slow speed, went one third of the circumference toward the top of the rattler then fell straight across a diameter against the shot and brick below. At the medium and fast speeds the shot would go to the top of the rattler before falling. This charge seemed very unsatisfactory for several reasons. First, the charge seemed to be too large, a great many of the cubes rolling on each other instead of on the brick, thus producing no abrasive effect on the brick, and interfering with the action of other cubes; then the per cent

of large shot in the total charge seemed to be too small, for the large shot if in the charge in greater amount would not allow the small cubes to go so high in the rattler before falling. This charge caused pounding in too great a degree and the long fall of the charge tended to give too great a loss from impact in proportion to the loss from abrasion. For these reasons, it was decided that 150#, 15% large was an unsatisfactory charge.

The second test, charge of 150#, 40% large, the one decided upon by Professor Orton was observed by several persons familiar with these tests and all were of the opinion that the charge of shot was too great. There was so much iron in the rattler that it did not all come in contact with the circle of brick, as it should, but rather a great deal of of the charge rolled upon itself, so that the cubes instead of wearing

away the brick, rubbed upon each other, in this way giving no additional value to the test. The other faults found in the first test were noticeable, although there was more of a tendency for the shot to roll, probably caused by the greater weight of large shot. Although this loading seems to be unsatisfactory, a final opinion cannot be given until a more suitable charge has been found. Professor Orton, after carefully conducted experiments, decided that this was the proper weight and proportions of shot, so it must have been the most satisfactory loading for the spacing of one inch as used by him, but the writers believe that a smaller charge will give better results and a sharper distinction between the different grades of brick. For this reason, experiments with less weights of brick were tried.

In the third test, a charge of 100#, 40% large shot, being used, there

was pounding for ten or fifteen revolutions at all speeds, then there was almost no pounding during rest of test. This seemed to be a very satisfactory charge, although the action of shot was more toward abrasion with not enough impact in proportion. The weight of material worn away is shown in Table I.

The next test with 75# of shot, 40% large was tried on a new loading of brick, and the rattler was run for only 100 revolutions for each of the three speeds, so no reliable data as to the weight of abraded material were obtained. The action of the shot on the brick, however, was the most satisfactory of any of the tests so far tried.

A charge of 100#, all large shot was then tried, and proved very unsatisfactory, as there was a great deal of pounding at all speeds, the pounding increasing with the speed. The losses are shown in the table.

Next, 75# of shot, all small, gave a fairly good test, although it seemed unnecessary to take any data, as it was at once evident that this was not the best loading. The high speed gave the best results when loaded in this way with all small shot.

The next test was with 65#, 40% large shot, on a new loading of brick. The losses are shown in the table. At the slow speed, the action of the shot was better than in the preceding test at any speed. At both the medium and fast speeds, the action was about the same and better than for the slow speed.

With 75# of shot, 33% large, there was some pounding, but hardly enough. See Table I for losses.

(b) Tests with Overburned Clinton brick.

Since the action of the shot on the brick appeared best with charges of 75# and 100#, tests were made with these loadings.

The rattler was run for some time

with a charge of 75#, 40% large, then the data was taken at the three speeds for 500 revolutions, repeating twice for the medium and fast speeds. The losses are shown in Table III.

This experiment was then performed with 100# of shot, 40% large in the same way.

There was some pounding with both charges, but hardly any more than was necessary to give right relation between impact and abrasion.

(c) Tests with Underburned Clinton brick.

Tests were made as stated in description of tests and losses are shown in Table IV.

Conclusions from Preliminary Tests.

In interpreting the results of these tests as given in Tables I, III, and IV, allowance must be made for the wear of the brick as the tests progressed, the total loss and the ratio of chips to total loss becoming less as the corners

of the brick are worn off.

The irregular motion, or pounding described in the results of the test with 150# of shot at 42 R.P.M. decreases with decrease in speed, decrease in size of charge, and increase in proportion of large shot. The proportion of loss due to chipping decreases as the irregular motion increases, this irregular motion causing wear of the charge instead of wear of the brick, as shown before.

With tests in which the charge has a fairly uniform motion the proportion of loss due to chipping decreases with decrease in size of charge. Tests with light charges at medium and fast speeds show little difference in the action of the shot, and little difference in results, except that the medium speed gives greater loss with overburned brick, as shown in Table III. For this reason, it was decided that the medium speed was best one to be used, so all of the final tests were made with rattler running 36 R.P.M.

(2) Results of Final Tests.

The data from these tests are shown in Tables II, V, VI, and VII. The 75# charge, 40% large shot gives the most satisfactory results. The motion of shot is more regular, and the proportion of loss due to chipping is less than with the larger charges. With a greater proportion of large shot than 40% the chipping becomes excessive. The distinction between different grades of brick is as marked as with the charges previously recommended, that is 150#, 40% large shot. The comparison is shown in Tables V and VI. In one case the 150# charge gives a greater distinction for the overburned brick, but this is probably due to the extra amount of chipping at the beginning of the test.

Using a 75# charge, the loss at 3000 revolutions did not give a large enough percentage of loss of total weight of the brick, so a longer test was tried. It was found that the loss continues quite uniform after 3000 revolutions,

and a test of 6000 revolutions gave excellent results. Tests of 6000 revolutions were run in Table VII. Mr. E. W. Block in his investigations for thesis, 1903, confirmed these results, and the writers refer to his thesis for more extensive results obtained under the standard conditions decided upon in this work.

This test gives a certain and clear distinction between the different grades of brick. It subjects the brick to action very similar to that received in the pavement, and moreover gives a very good relation between the losses due to impact and abrasion.

Conclusions.

Following are the conditions for a standard test with the Talbot-Jones Brick-Testing Machine;
(1) A spacing of 1/4 inch between bricks, at
(2) a speed of 36 revolutions per minute
(3) loaded with 75# of shot, 60% or 45# being 1 1/2 inch cubes, and 30#, or 40%, 2 3/8 inch cubes, the rattler running for
(4) 6000 revolutions. This requires two and three quarter hours for a complete test.

TABLE I

AMOUNT OF ABRASION FOR VARIOUS CHARGES & SPEEDS
GOOD CLINTON BLOCK

CHARGE	WEIGHT (OZ.) OF ABRADED MATERIAL PER 100 REVOLUTIONS					
	30 Rev. per Min.		36 Rev. per Min.		42 Rev. per Min.	
	CHIPS	TOTAL	CHIPS	TOTAL	CHIPS	TOTAL
150 Lbs 15% Large	8	15	4½	12	3	9
"	9	17	4	8	3	8
"	6	12	2	6	1	5
150 Lbs 40% Large	3½	12	4	11	2	8
"	5	11	3	8	2	8
"	3½	9	2½	9	2	8
100 Lbs 40% Large	1	4	1½	5	½	4½
"	1½	5	1	4½	½	4½
"	1½	6	1	4½	—	—
75 Lbs 40% Large	½	2½	½	3	½	2½
100 Lbs 100% Large	3½	11	7	11	2	5½

TABLE II

COMPARISON OF 75 LB. AND 100 LB. CHARGES

Each Test 200 Rev. 36 Rev. per Minute

Good Clinton Block

LARGE SHOT PER CENT OF TOTAL	AMOUNT OF ABRADED MATERIAL			
	75 LB. CHARGE		100 LB CHARGE	
	CHIPS Oz.	TOTAL Oz.	CHIPS Oz.	TOTAL Oz.
0	16	23	9	19
40	7	15	10	18
60	8	19	6	13
60	2½	8	5	13
40	1	6	3	10
0	1	5	1	6

TABLE III

COMPARISON OF MEDIUM AND FAST SPEEDS FOR 75 POUND AND 100 POUND CHARGES

40 PER CENT LARGE SHOT

Overburned Clinton Block

Each Test 500 Rev. 36 Rev. per Minute

WEIGHT of CHARGE Pounds	AMOUNT OF ABRADED MATERIAL			
	36 Rev. per Min.		42 Rev. per Min.	
	CHIPS oz.	TOTAL oz.	CHIPS oz.	TOTAL oz.
75	15	42	9	32
	17	49	4	26
100	7	43	6	38

TABLE IV

COMPARISON OF 65 LB., 75 LB. & 150 LB. CHARGES

40 PER CENT LARGE SHOT

Each Test 200 Rev. 36 Rev. per Minute

Underburned Clinton Block

WEIGHT of CHARGE Pounds	AMOUNT OF ABRADED MATERIAL	
	CHIPS oz.	TOTAL oz.
75	4	9
100	7	16
65	4	9

TABLE V

COMPARISON OF 75 LB. AND 150 LB. CHARGES
40 PER CENT LARGE SHOT
Clinton Block

GRADE	LOSS IN PER CENT OF ORIGINAL WEIGHT		
	75 LBS. SHOT		150 LBS. SHOT
	3000 Rev.	6000 Rev.	500 Rev.
Underburned	5.3	8.6	1.1
Good	4.0	6.9	.9
Overburned	6.2	9.9	1.0

Tests with 150 lbs. shot made after tests with 75 lbs., on same brick and on same face of brick.

TABLE VI

COMPARISON OF 75 LB. AND 150 LB. CHARGES
40 PER CENT LARGE SHOT
Clinton Block

GRADE	LOSS IN PER CENT OF ORIGINAL WEIGHT	
	75 LBS. SHOT 6000 Rev.	150 LBS. SHOT 3000 Rev.
Underburned	8.6	9.4
Good	7.0	8.0
Overburned	9.3	13.0

Same brick as used for tests with 75 lbs shot, tested on opposite face.

TABLE VII

PROPORTION OF LOSS DUE TO CHIPPING

Charge: 75 lbs. shot, 40 per cent large

REVOLUTIONS	LOSS					
	SOFT BRICK		GOOD BRICK		HARD BRICK	
	CHIPS Oz.	TOTAL Oz.	CHIPS Oz.	TOTAL Oz.	CHIPS Oz.	TOTAL Oz.
3000 to 3500	7	38	3	17	6	21
3500 " 4000			3	17	6	21
4000 " 4500	3	20	5	16	3	18
4500 " 5000	3	19	3	14	5	22
5000 " 5500	2	20	3	16	5	20
5500 " 6000	5	23	2	14	3	19
3000 " 6000	20	120	19	94	28	121